

Serial No.: 09/544,344

PATENT APPLICATION  
Docket No.: NC 84,337**REMARKS**

Claims 1, 2, 4-9, 21, 22, 25-38, and 40-51 are pending in the application. Claims 46-51 have been added by this amendment. Claims 1, 2, 4-9, 21, 22, 25-27, 29-38, and 40-45 have been rejected. Claim 28 has been objected to. Claims 28, 35-38, 40, and 42 have been held to recite patentable subject matter.

Claims 1, 21, 25, 27, 33, 34, and 41 are amended to recite "ligand shell molecule" instead of "ligand molecule" for consistency with other claims.

Claims 1, 25, and 27 are amended to recite that the tail has a tail functional group capable of selective interactions that discriminate between chemical species of interest, the tail functional group selected from the group consisting of a heterofunctional group, an aromatic group, a secondary aliphatic group, and a tertiary aliphatic group. This limitation is incorporated from claim 9 and has further support at page 12, line 23 to page 13, line 9.

Claims 1, 33, and 34 are amended to recite that the particles are supported by a substrate and are presented to contact the environment. Support for this amendment is found in claim 21.

Claim 4 is amended to recite "its structure" instead of "the ligand shell molecule" for clarity.

Claim 6 is amended to recite "ligand shell molecule" instead of "ligand shell" for consistency with claim 1; to recite that the amine is in the head portion as recited in claim 4; and to cancel the limitation that the amine is a primary aliphatic amine.

Claim 9 is amended to cancel the limitation incorporated into claim 1.

Claims 9 and 40 are amended to recite "ligand shell molecule" instead of "ligand molecule shell" for consistency with claim 1.

Claim 21 is amended to change the upper end of the thickness range to 10,000 nm. Support for this amendment is found at page 20, line 20.

Claim 26 is amended to change "ligand" to "ligand shell molecule" for consistency with claim 25.

Claim 26 is amended to cancel "primary aliphatic thiols."

Claims 29 and 31 are amended to cancel the description of the particles, as the description is already recited in parent claim 27.

Claim 33 is amended to change "such" to "said."

Claims 37 is amended to recite "heterofunctional group" instead of various thiols, and to

Serial No.: 09/544,344

PATENT APPLICATION  
Docket No.: NC 84,337

correct the dependency from claim 5 to claim 1. Support for this amendment is found in previous claim 9.

Claim 38 is amended to recite a ligand molecule instead of "heterofunctionally substituted aliphatic thiol." Support for this amendment is found in claim 1 before amending.

Claim 40 is amended to correct a spelling error and to remove the redundant recitation now incorporated into parent claim 1.

Claim 41 is amended to cancel redundant "or's."

Claim 44 is amended to recite "coupling agent" instead of "difunctional material" for consistency with claim 31.

Claims 44 and 45 are amended to recite "molecule" instead of "coupling agent" for clarity.

Claim 45 is amended to change the dependency to claim 29.

New claims 46-48 recite specific reagents. Support for claim 46 is found at page 24, line 20 and page 13, lines 10-11. In claim 47, support for benzyl mercaptan is found at page 35, line 12; support for phenylethyl mercaptan is found at page 35, line 19; support for araliphatic mercaptan is found at page 13, line 6; and support for 4-methoxybenzyl mercaptan is found at page 36, line 1. In claim 48 support for dithiol and hexanedithiol is found at page 17, lines 27-25; and support for octanedithiol is found at page 39, line 18.

New claim 49 recites an upper limit to the film thickness of about 400 nm. Support for this amendment is found at page 27, line 13.

New claim 50 recites the substitutions from claim 37 on the other tail groups from claim 1.

New claim 51 recites a subset of the Markush group from claim 1.

No new matter has been added.

A Notice of Appeal is filed with this amendment.

#### Docket Number

Please change the docket number of this application to NC 84,337.

#### Claim Rejections – 35 U.S.C. § 112

Claims 1, 2, 4-9, 33-38, and 40-42 have been rejected under 35 U.S.C. § 112, first

Serial No.: 09/544,344

PATENT APPLICATION  
Docket No.: NC 84,337

paragraph as being allegedly nonenabled for failure to recite that the particles are on a substrate.

1 (2, 4-9, 37, 38, and 40-42 dependent thereon), 33, and 34 (35 and 36 dependent thereon) have been amended to recite that the particles are supported by a substrate. This amendment obviates the rejection.

Claims 37 and 38 have been rejected under 35 U.S.C. § 112, second paragraph as being allegedly indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. The claims were rejected for lack of antecedent basis for "said heterofunctionally substituted aliphatic thiol." Claim 37 has been amended to depend from claim 1 and to recite "said heterofunctional group," which is introduced in claim 1. Claim 38 has been amended to depend from claim 1 and to recite "said ligand shell molecule," which is introduced in claim 1.

#### Claim Rejections – 35 U.S.C. § 102

Claims 1, 2, 4, 5, 7-9, 21, 22, 25-27, 33, 34, and 41 have been rejected under 35 U.S.C. § 102(b) as allegedly anticipated by Bethell et al. (*J. Electroanal. Chem.*).

Claim 1 is to an article of manufacture comprising a multiplicity of particles in three-dimensional close-packed orientation and a substrate suitably configured for supporting the multiplicity of particles and presenting the multiplicity of particles to contact with said environment. The particles have a core of conductive metal or conductive metal alloy of 0.8 to 40.0 nm in maximum dimension and deposited on said core a ligand shell of thickness from 0.4 to 4.0 nm. The ligand shell is composed of an encapsulating monomolecular layer of ligand shell molecules each molecule having a head-tail type structure. The head has a functional group possessing a bonding interaction with metal atoms in the core surface. The tail has a structure and composition designed to provide additional stabilization of metal clusters against irreversible agglomeration, induce solubility in solvents, and promote interactions with chemical species of interest and has a heterofunctional group capable of selective interactions that discriminate between chemical species of interest. The ligand shell is capable of interacting with a chemical species in a target environment such that an electrical property of said multiplicity of particles is altered.

Bethell discloses a colloidal solution of nonanethiol-derivatized gold nanoparticles (page

Serial No.: 09/544,344

PATENT APPLICATION  
Docket No.: NC 84,337

138, left column, 2<sup>nd</sup> full paragraph). Bethel also discloses a structure made layer-by-layer from a substrate, gold nanoparticles, and a dithiol (page 139, 1<sup>st</sup> full paragraph and Fig. 3).

In order to make a *prima facie* case of anticipation, the reference must disclose each limitation of the claim. Among other deficiencies, the reference does not disclose the combination of limitations in claim 1 that the particles are in three-dimensional close-packed orientation on a substrate, and that the tail has a structure and composition designed to provide additional stabilization of metal clusters against irreversible agglomeration. Since the tail stabilizes against irreversible agglomeration, the ligand shell molecule cannot be a dithiol of the type used in Bethell. (Some dithiols can be within the scope of the claims. For example, a dithiol where one thiol group is sterically hindered from binding to a second nanoparticle may be used.) Bethell's dithiols actually promote irreversible agglomeration by bonding nanoparticles together, as shown in Fig. 3 of Bethell. The Examiner stated that the independent claims do not place any limitation on the tail portion of the ligand and that the instant specification teaches the use of a dithiol, which would make dithiol within the scope of the claims (office action of 12/10/2004, page 7, lines 20-25). However, the recitation that the tail stabilizes against irreversible agglomeration does limit the structure of the tail. Also, this use of a dithiol recited in the specification is in addition to the presence of a ligand shell molecule, where the ligand shell molecule is not this kind of dithiol. Note that according to the instant specification, a dithiol coupling agent may displace a ligand shell molecule (page 18, lines 4-9), though not all ligand shell molecules are displaced.

Bethell's three-dimensional structure contains a dithiol coupler, but not a ligand shell molecule as recited in claim 1. The ligand shell molecule is significant in that it allows for the ligand shell to be capable of interacting with a chemical species in a target environment such that an electrical property of the particles is altered, as recited in claim 1. The three-dimensional structure of Bethell does not have this property.

Bethell's colloidal solution of nonanethiol-derivatized gold nanoparticles does not contain three-dimensional close-packed particles on a substrate. Nothing in Bethell enables or suggests that such a structure could be made with these particles.

Further, Bethell does not disclose the limitation that the tail has a heterofunctional group, an aromatic group, a secondary aliphatic group, or a tertiary aliphatic group. Although Bethell does disclose a thiol group in the tail, this does not meet the limitation, as such a group causes

Serial No.: 09/544,344

PATENT APPLICATION  
Docket No.: NC 84,337

agglomeration. Since such a thiol group cannot be in the tail, it cannot be the recited tail functional group. It should be noted that a thiol heterofunctional group may be possible if, for example, it is sterically hindered so that it does not cause agglomeration, however, this is not the case in Bethell.

Claims 2, 4, 5, 7-9, and 41 depend from and contain all the limitation of claim 1 and are asserted to distinguish from the reference in the same manner as claim 1. Claims 21 and 25 are each directed to an assembly and claims 33 and 34 are each directed to a system, each claim reciting three-dimensional close-packed particles on a substrate as recited in claim 1 (only claim 25 reciting the heterofunctional group) and are asserted to distinguish from the reference in the same manner as claim 1. Claims 22 (dependent on claim 21) and 26 (dependent on claim 25) are asserted to distinguish from the reference in the same manner as claim 1. Claim 27 is directed to a method of fabricating an assembly also comprising three-dimensional close-packed particles on a substrate as recited in claim 1 and is asserted to distinguish from the reference in the same manner as claim 1.

#### Claim Rejections – 35 U.S.C. § 103

Claims 2, 4, 6, and 22 have been rejected under 35 U.S.C § 103(a) as allegedly unpatentable over Bethell in view of Natan (US 5,609,907).

Natan discloses formation of two dimensional arrays of colloidal particles on a surface (abstract).

In order to make a *prima facie* case of obviousness, each claim limitation must be disclosed in the references. As in Bethell, Natan does not disclose three-dimensional close-packed particles on a substrate, nor particles having a ligand shell as recited in claims 1 (claims 2, 4, and 6 dependent thereon) and 21 (claim 22 dependent thereon). As all the claim limitations are not disclosed in the references, a *prima facie* case of obviousness has not been made.

Claims 27, 29-32, and 43-45 have been rejected under 35 U.S.C § 103(a) as allegedly unpatentable over Bethell in view of Terrill (*J. Am. Chem. Soc.*) and Andres (*Science*).

Terrill discloses films of gold clusters stabilized by alkanethiolates (abstract).

Andres discloses monolayers of gold clusters encapsulated by alkyl thiols and, optionally, interconnected by dithiols (Abstract)

Serial No.: 09/544,344

PATENT APPLICATION  
Docket No.: NC 84,337

Claim 27 is directed to a method of fabricating an assembly comprising: depositing on a substrate a pair of interdigitated electrodes each having a comb-like configuration and a thin film of the particles as also recited in claim 1 in such manner that the electrodes are electrically connected; and connecting the pair of electrodes with a sensor capable of determining a change in the electrical property of the particles. It should be noted that the heterofunctional group would not be a group that would cause irreversible agglomeration as explained above, such as thiol or isocyanate.

Neither Terrill nor Andres discloses the limitation in claim 27 that the tail has a heterofunctional group, an aromatic group, a secondary aliphatic group, or a tertiary aliphatic group. All the ligands in Terrill are unsubstituted C<sub>8</sub>, C<sub>12</sub>, or C<sub>16</sub> primary alkane thiols. Andres discloses only an unsubstituted C<sub>12</sub> primary alkane thiol, which does not have the above tail group, and aryl dithiols and aryl di-isocyanates, which cause agglomeration. As explained above, Bethell also does not disclose this limitation. As all the claim limitations are not disclosed in the references, a *prima facie* case of obviousness has not been made.

Claims 29-32 and 43-45 depend from and contain all the limitation of claim 27 and are asserted to distinguish from the reference in the same manner as claim 27.

In view of the foregoing, it is submitted that the application is now in condition for allowance.

In the event that a fee is required, please charge the fee to Deposit Account No. 50-0281, and in the event that there is a credit due, please credit Deposit Account No. 50-0281.

Respectfully submitted,



Joseph T. Grunkemeyer  
Reg. No. 46,746  
Phone No. 202-404-1556  
Office of the Associate Counsel  
(Patents), Code 1008.2  
Naval Research Laboratory  
4555 Overlook Ave, SW  
Washington, DC 20375-5325